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DYNAMICS OF SUSPENDED SEDIMENT PLUMES IN LAKE ONTARIO

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16. Abstract The suspended sediment plumes generated by the Welland Canal and the Genesee River are identifiable in most band 5 frames received from ERTS-1. In descending order of value for plume detection in Lake Ontario are bands 4, 6, and 7. Little or no information content relative to plume detection is available in band 7. The Oswego River plume was not visible during low flow periods; however, it was identifiable immediately following storms. Increased suspended sediment loading emanating from storm runoff increases turbidity levels to the point where the plume becomes visible in the ERTS imagery. Despite the fact that it is detectable from high-altitude (60,000 ft.) photography, the Niagara River plume was <u>not</u> visible in any of the ERTS-1 frames. Numerous examples of shoreline erosion were evident in the December 7, 1972, imagery of western Lake Ontario. Near shore lake circulation patterns are usually apparent whenever turbidity plumes are sensed by the satellite.					
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Figure 2A. Technical Report Standard Title Page. This page provides the data elements required by DoD Form DD-147, HEW Form OE-6000 (ERIC), and similar forms.

Type II Progress Report
ERTS-1

a. DYNAMICS OF SUSPENDED SEDIMENT IN LAKE ONTARIO

ERTS-1 Proposal No.: 342-4

b. GSFC ID No.: IN 058

c. Statement and explanation of any problems that are impeding the progress of the investigation:

Late delivery of the imagery hampered data analysis prior to October 1972. Improvement in the delivery schedule was noted during November and this promising trend is continuing.

d. Discussion of the accomplishments during the reporting period and those planned for the next reporting period:

Ground truth in the form of turbidity, water temperature, and suspended sediment measurements along the south shore of Lake Ontario were obtained August 9, 10, 17, 18, September 25, 26, October 30, 31, and November 1. Additionally, wind speed and direction, sky cover, and sea state observations were made at each measurement site. Future plans call for one winter ground-truth collection trip to be made concurrently with a satellite overpass of each of the three Lake Ontario study sites. Ground-truth trips during spring freshets are also planned (principally during March and April). A trip to the Stanford Research Institute likely will be made to evaluate the potential of SRI's time-lapse console to identify lake dynamics from ERTS imagery.

e. Discussion of significant scientific results and their relationship to practical applications or operational problems including estimates of the cost benefits of any significant results:

Major turbidity features such as the Welland Canal and Genesee River plumes are readily identifiable in all cloud-free imagery -- both watercourses are sediment laden and highly turbid. For example, turbidity measurements of 20 to 50 JTU (Jackson Turbidity Units) are not uncommon during the shipping season in the Welland Canal.

Turbidity measurements of 10 to 25 JTU are fairly common at the mouth of the Genesee River even during dry weather periods. Accordingly, the movement of longshore currents at the mouths of both watercourses is readily discernible. On August 20, 1972, ERTS imagery showed a tight counterclockwise circulation to the west of the Genesee River outlet jetty. This turbid area did not extend into the lake beyond the mouth of the river. The plume was confined to a zone between the shore and the extreme outer end of the jetty by northeast winds. By way of contrast, on September 6, 1972, the Genesee River plume was visible at a distance of 3 1/2 miles out into the lake beyond the outer end of the jetty. At that time, a 5-to 10-knot southerly breeze forced the turbid waters away from the beaches flanking the mouth of the river. Given real-time information, ERTS imagery can be used by health officials to warn bathers of possible health hazards under varying wind conditions.

The Oswego River plume was visible in the imagery for August 19, 1972, but was not visible on imagery obtained September 6, 1972. Light to moderate rainfall just prior to the ERTS overpass on August 19 generated enough runoff to raise turbidity values in the river to a level sufficient to permit sensing by the satellite. Dry weather prior to the September 6 imagery resulted in low suspended sediment concentrations in the river. Accordingly, tonal contrasts between the river and the lake were reduced beyond the satellite's sensing capability.

The most surprising feature of all, to date, is the inability of the satellite to detect the Niagara River plume. This plume, generated by a flow averaging over 200,000 cfs is normally identifiable in high-altitude photography (60,000 ft). However, turbidity levels in the Niagara River jet are low, often near 1 JTU indicating that sediment concentrations are also low. The Niagara River jet likely gains much of its turbidity from its erosive action against the lake bottom -- a process which results in scour and subsequent suspension of benthic lake sediments. Turbidity levels within the body of the plume are dependent not so much on transported upriver material but on littoral drift being fed into the river jet along its flanks and from scouring and resuspension of lake bottom material. The

supply of suspended material from these sources is normally small so that low turbidity levels are a characteristic of the Niagara River plume.

The position of the western and northern boundaries of the plume were, nevertheless, identifiable on the imagery for August 21, 1972. At that time a southwesterly breeze caused the Welland Canal plume to move in an easterly direction toward the mouth of the Niagara River. The lighter tone waters of the Welland plume (4 to 6 JTU) contrasted sharply with the clearer, darker waters (1 to 2 JTU) of the Niagara plume to the east. A very sharp line of demarcation formed between the light toned eastward moving waters of the Welland plume and the westward and northward spreading waters of the Niagara River plume.

Excellent examples of shoreline erosion and littoral circulation patterns are portrayed in the imagery for December 7, 1972. Under the influence of a general westerly air circulation, erosive longshore currents were generated in the western portion of Lake Ontario. Erosion appeared especially severe between Hamilton and Port Dalhousie, Ontario where extensive turbidity plumes were in evidence. These plumes suggest the presence of active littoral currents which were moving in a general west-to-east direction along the shoreline.

Category designation 4D, 5H, 7C

f. A listing of published articles, and/or papers, preprints, in-house reports, abstracts of talks, that were released during the reporting period:

None.

A paper "Remote sensing of turbidity plumes in Lake Ontario" was submitted for Director's approval for publication in the Survey Journal.

g. Recommendation concerning practical changes in operations, additional investigative effort, correlation of effort and/or results as related to a maximum utilization of the ERTS system.

Some additional reduction in the time required to distribute imagery to the Principal Investigators would help improve field operations. Faster delivery time would enable Principal Investigators to detect unusual seasonal features in time to permit spot field checks.

h. A listing by date of any changes in Standing Order Forms:

None.

i. ERTS Image Descriptor forms:

In preparation.

j. Listing by date of any changed Data Request forms submitted to Goddard Space Flight Center/NDPF during the reporting period:

None.